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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Signals of El Niño Modoki in the tropical tropopause layer and stratosphere" *by* F. Xie et al.

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This manuscript compared the tropical tropopause layer and the stratosphere under El Nino Modoki events versus conventional El Nino events using observational data and time-slice model simulations. The authors defined El Nino signals based on compositing analysis and EOF analysis. They found different types of El Nino events show differences in OLR, TTL temperature and water vapor distribution, tropical stratospheric water vapor distribution, and polar vortex in high latitude stratosphere. In particular, the authors concluded that the nonlinear interaction between El Nino Modoki and QBO leads to opposite El Nino Modoki signals in high latitude stratosphere against conventional El Nino. This manuscript is well written and present interesting results on El Nino Modoki, which is a relatively new phenomenon. However, the robustness of some results in this paper is questionable, and need to be addressed before this paper can be published in ACP.

Major concerns:

The authors applied compositing analysis on a relatively short record of observational data, during which only a few El Nino events occurred. Given this relatively small sample size, it is crucial to assess the uncertainty and the robustness of the signals. For example, the temperature signals in high latitude stratosphere in Fig. 9 is less than 1K. But the temperature there can easily change by a few K from one year to another, then the seemingly El Nino signal may not be significant compared to the inter-annual variability, and could be resulted from an uneven sampling. In fact, the authors described their results as "significant" or "robust" on many occasions, but no uncertainty estimation or statistical significance analysis or any sensitivity tests are provided. Hence it is nor clear what ground those significance or robustness are based upon.

In particular, the authors used the 6 years MLS data to assess the stratospheric water vapor distribution during canonical El Nino and El Nino Modoki events. During these 6 years, there is only one canonical El Nino event lasting 6 months and one El Nino Modoki event lasting 6 months. Give such small sample size, I don't think compositing analysis will give very meaningful results in this case. The difference between those 6 months and the 6-year average could be caused by other things besides El Nino, for example, QBO, or some other random internal variability. The authors claimed that the analysis of MLS data provides more robust results than ERA-Intrim data. I am not sure this is based on what ground because no uncertainty estimation is provided in the paper. I assumed the authors were referring to smaller spread within El Nino group in MLS data, but that is because those MLS data in El Nino group are not independent from each other (since there is only one event).

The limitation of the observational data may be inevitable, and the authors did a good job to use model simulations to support their observational results. However, these simulations are run with one ensemble and for a relatively short period, and no uncertainty estimation is provided.

Other issues:

It would be helpful if the authors can provide some details of the compositing analysis, such as how many El Nino events are considered and when are those events? is there any overlapping between the canonical El Nino group and the El Nino Modoki group? Are the results sensitive to the choice of the El Nino index, or to the choice of the threshold of the index? I noticed that the authors chose a lower threshold compared to some recent similar compositing analysis (e.g., Hurwitz et al. 2011A, Zubiaurre and Calvo 2012).

P3631 L14-28: The authors showed that El Nino events have different effects on water vapor concentration in the lowermost, lower and middle stratosphere. It is not clear why the water vapor signals on different levels should be different given that they are all regulated by the tropopause temperature as suggested by the authors. Is there any physical basis to expect the different El Nino signals in the middle stratosphere and the lower stratosphere? Or is the difference between middle stratosphere and lower stratosphere resulted from sampling issue and not related to El Nino?

P 3634-3635 This discussion about the interaction of QBO and ENSO Modoki is very interesting. However, the results presented in this paper seems to be contrary to conclusions of a few recent studies (Hurwitz et al. 2011B, Zubiaurre and Calvo 2012, Sassi et al. 2004). These studies all used Chemistry Climate Models to study the El Nino Modoki signal in the stratosphere, and they concluded that the El Nino Modoki signal in the stratosphere is not sensitive to QBO phases. In particular, Sassi et al. (2004) used a similar model (WACCM1b) to what the authors used (WACCM3), and did not simulate or impose a QBO, but found significant warming in the SH polar stratosphere under El Nino Modoki events. It would strengthen the paper if the authors can comment on the difference against these studies.

Technical issues:

P3621 L15: temperatures → temperature

P3632 L15-16: vertical velocity is not in the above equations, while u, v, phi, f are in the equations but not explained.

P3650 The text suggested this figures is based on MLS data, but the caption says it is based on ERA-Intrim data.

Reference:

Hurwitz, M. M., P. A. Newman, L. D. Oman, and A. M. Molod (2011b), Response of the Antarctic stratosphere to two types of El Niño events, J. Clim., 68, 812–822, doi:10.1175/2011JAS3606.1.

Hurwitz, M. M., I. S. Song, L. D. Oman, P. A. Newman, A. M. Molod, S. M. Frith, and J. E. Nielsen (2011B), Response of the Antarctic stratosphere to warm pool El Niño events in the GEOS CCM, Atmos. Chem. Phys., 11, 9659–9669, doi:10.5194/acp-11-9659-2011.

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Zubiaurre, I., and N. Calvo (2012), The El Nino-Southern Oscillation (ENSO) Modoki signal in the stratosphere, J. Geophys. Res., 117, D04104, doi: 10.1029/2011JD016690.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 3619, 2012.